

Claims

1. A photonic material comprising a core and an envelope:
said core comprising at least one nanoparticle, said nanoparticle comprising an inorganic material and at least one luminescent ion, said inorganic material suitably selected to bind said luminescent ion; and
said envelope comprising a suitably selected organic stabilizing layer overlying said core.
2. The photonic material of claim 1, wherein said organic stabilizing layer is suitably selected for reducing quenching.
3. The photonic material of claim 1 or 2, wherein said organic stabilizing layer comprises a functional group-presenting material and at least one functional group.
4. The photonic material of claim 3, wherein said functional group binds an at least one luminescent ion.
5. The photonic material of claim 4, wherein said luminescent ion is a lanthanide ion.
6. The photonic material of any one of claims 3 to 5, wherein said functional group-presenting material comprises at least one ligand.

7. The photonic material of claim 6, wherein said ligand is selected to be suitable for ligand exchange reactions.
8. The photonic material of any one of claims 3 to 5, wherein said functional group-presenting material is a polymer.
9. The photonic material of any one of claims 1 to 8 wherein said organic stabilizing layer is self-assembled.
10. The photonic material of any one of claims 1 to 9 wherein said organic stabilizing layer further comprises one of hole conductors, electron conductors or a suitably selected combination of hole conductors and electron conductors.
11. The photonic material of claim 10, wherein said hole conductors comprise heterocyclic compounds.
12. The hole conductors of claim 11, wherein said heterocyclic compounds are aromatic amines.
13. The electron conductors of any one of claims 10 to 12, wherein said electron conductors are aromatic or heterocyclic compounds with suitably selected reduction potentials.

14. The photonic material of claim 13, wherein said aromatic or heterocyclic compounds are one of oxadiazoles, 1,2,4-triazoles, 1,3,5-triazines, quinoxalines, oligo- and polythiophenes and oligo- and polypyrroles.
15. The photonic material of any one of claims 1 to 14, wherein said envelope is suitably selected for preparing a sol-gel derived material.
16. The photonic material of any one of claims 1 to 14, wherein said envelope is suitably selected for solubility in an aqueous environment.
17. The photonic material of any one of claims 3 to 16, wherein said envelope is suitably selected to permit modification of said functional groups.
18. The photonic material of any one of claims 1 to 17, wherein said at least one luminescent ion is a lanthanide ion.
19. The photonic material of claim 18, wherein said lanthanide ion is selected from the group consisting of Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm and Yb.
20. The photonic material of claim 19, wherein said lanthanide ion is selected from the group consisting of Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and combinations thereof such that said photonic material emits in the UV-Vis wavelength range.

21. The photonic material of claim 19, wherein said lanthanide ions are selected from the group consisting of Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and combinations thereof, such that said photonic material emits in the (near-)infrared wavelength range.
22. The photonic material of any one of claims 1 to 21, wherein said inorganic material is a semiconductor or an insulator, suitably selected to promote sensitized emissions.
23. The photonic material of claim 22, wherein said inorganic material is a semiconductor.
24. The photonic material of claim 23, wherein said semiconductor is selected from the group consisting of Al_2S_3 , Ga_2O_3 , In_2O_3 , InP, GaAs, InAs, Ga_2X_3 ($\text{X} = \text{S}, \text{Se}, \text{Te}$), In_2X_3 ($\text{X} = \text{S}, \text{Se}, \text{Te}$), Ln_2X_3 ($\text{Ln} = \text{lanthanide}$ and $\text{X} = \text{S}, \text{Se}, \text{Te}$), TiO_2 and suitably selected alloys thereof.
25. The photonic material of claim 24 wherein said semiconductor is Al_2S_3 and said luminescent ion is Eu.
26. The photonic material of claim 22, wherein said inorganic material is an insulator.
27. The photonic material of claim 26, wherein said insulator is selected from the group consisting of LaPO_4 , GdPO_4 , YbPO_4 , LuPO_4 and LaF_3 , LaVO_4 , YVO_4 , LnPO_4

(Ln = lanthanide or Y), LnVO_4 (Ln = lanthanide or Y), LnX_3 (Ln = lanthanide and X = Cl, Br, I).

28. The photonic material of claim 27 wherein said insulator is LaF_3 .
29. The photonic material of any one of claims 1 to 28, further comprising a suitably selected inorganic shell, said inorganic shell located between said core and said envelop.
30. The photonic material of claim 29 wherein said shell comprises a suitably selected semi-conductor.
31. The photonic material of claim 30 wherein said shell comprises a semi-conductor selected from the group consisting of Al_2S_3 , Ga_2O_3 , In_2O_3 , InP , GaAs , InAs , Ga_2X_3 (X = S, Se, Te), In_2X_3 (X = S, Se, Te), Ln_2X_3 (Ln = lanthanide and X = S, Se, Te), TiO_2 .
32. The photonic material of claim 29 wherein said shell comprises an insulator.
33. The photonic material of claim 32 wherein said insulator comprises LnX_3 , wherein X is a halide.
34. The photonic material of claim 32 wherein said insulator is LaPO_4 .
35. The photonic material of claim 33 wherein said insulator is LaF_3 .

36. The photonic material of claim 32, wherein said insulator is selected from the group consisting of GdPO_4 , LuPO_4 , and YPO_4 .
37. The photonic material of any one of claims 29 to 36, wherein said shell further comprises at least one luminescent ion.
38. The photonic material of claim 37, wherein said at least one luminescent ion is a lanthanide ion.
39. The photonic material of claim 38, wherein said lanthanide ion is selected from the group consisting of Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm and Yb.
40. The photonic material of claim 39, wherein said lanthanide ion is selected from the group consisting of Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and combinations thereof such that said photonic material emits in the UV-Vis wavelength range.
41. The photonic material of claim 40, wherein said lanthanide ions are selected from the group consisting of Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and combinations thereof, such that said photonic material emits in the (near-)infrared wavelength range.
42. A method of preparing a photonic material comprising selecting a suitable inorganic material and a suitably luminescent ion, preparing an at least one

nanoparticle therefrom to provide a core, and enveloping said core with a suitably selected organic material to provide an envelope.

43. The method of claim 42, further comprising selecting said organic stabilizing layer to reduce quenching.

44. The method of claim 42 or 43, wherein said organic stabilizing layer comprises a functional group-presenting material and at least one functional group and said functional groups are exchanged.

45. The method of any one of claims 42 to 44, further comprising selecting a suitable inorganic material to provide a shell, covering said core with said shell and enveloping said shell with said envelope.